

Anaesthetic Considerations in an Achondroplastic Child with Thermal Burns: A Case Report

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ABSTRACT

Achondroplasia is the most common cause of disproportionate dwarfism and is associated with multiple systemic abnormalities that pose unique challenges to anaesthetic management. Characteristic features such as hypotonia, delayed motor development and obesity often complicate perioperative care. Craniofacial anomalies, including midface hypoplasia, macrocephaly and cranio-cervical junction compression, increase the likelihood of a difficult airway. Additionally, skeletal deformities such as thoracolumbar kyphosis, spinal canal stenosis and abnormal vertebral anatomy make neuraxial anaesthesia technically challenging. Fluid and electrolyte imbalances, hypovolemia and altered pharmacokinetics further complicate drug dosing and anaesthetic selection. Present case is of a 13-year-old child with achondroplasia who sustained extensive thermal burns following accidental kerosene exposure and subsequently required split-thickness skin grafting under general anaesthesia. This case highlights the importance of anticipating anaesthetic complications in patients with achondroplasia and burns and of adopting an individualised, multidisciplinary approach to ensure safe outcomes. Ultrasound guidance was used to facilitate intravenous access. The anticipated difficult airway was managed with video laryngoscopy to minimise cervical spine movement. Muscle relaxation was achieved with rocuronium and reversed with sugammadex. The intraoperative course was uneventful and the patient was discharged the following day.

Keywords: Airway management, Cranio-cervical junction, Hypotonia, Sleep apnoea, Thoracolumbar kyphosis

CASE REPORT

A 13-year-old girl with achondroplasia who presented with a history of 30% second-degree accidental kerosene burns sustained one day prior to surgery, involving the anterior chest, trunk, thighs and lateral and medial aspects of the forearms [Table/Fig-1,2]. She weighed 30 kg, stood four feet tall, and had a trident hand [Table/Fig-3]. The burns were deep, ranging from partial to full thickness. There was no inhalation injury and the calculated Baux score was 43, indicating a favourable survival probability for her age. Her birth history was uneventful and she had achieved developmental milestones at the appropriate ages. A positive history of snoring was elicited from her parents. She was scheduled for wound wash and split-thickness skin grafting under general anaesthesia.



[Table/Fig-1]: A 13-year-old female child with achondroplasia posted for split skin grafting.

On preoperative evaluation, her heart rate was 110 beats per minute, blood pressure was 100/60 mmHg, and SpO₂ was 98% on room air. Laboratory investigations revealed a normal complete blood count and serum electrolytes. Preoperative cardiac evaluation, including electrocardiogram and echocardiogram, showed normal findings, with a left ventricular ejection fraction of 62%. X-ray of the neck



[Table/Fig-2]: Extensive second- and third-degree burns involving the anterior trunk and both thighs.



[Table/Fig-3]: Trident hand deformity with widened interdigital spaces and inability to approximate the fingers, a classical feature of achondroplasia.

ruled out atlantoaxial dislocation. A difficult airway was anticipated due to a short neck with excess soft-tissue, a large tongue with a small oral orifice and a Modified Mallampati Score of 3. She was

classified as American Society of Anaesthesiologists (ASA) Grade II. Informed consent was obtained from her parents before transferring the patient to the operating theatre.

Standard monitoring was applied and the patient was preoxygenated with 100% oxygen for three minutes. Inhalational induction was performed using 2% sevoflurane, followed by securing intravenous access with ultrasound guidance. Muscle relaxation was achieved with rocuronium 0.6 mg/kg i.v., and the airway was secured using a Sandor (SANVL2) video laryngoscope with a 6.5-mm endotracheal tube while keeping the neck immobilised. Anaesthesia was maintained with a mixture of oxygen, air, and 2% sevoflurane (MAC 1). End-tidal carbon dioxide (EtCO₂) was maintained between 35 and 45 mmHg. Pressure points were adequately padded. The patient was ventilated in volume control mode, with a tidal volume of 250 mL, a respiratory rate of 14 breaths per minute, and Positive End-Expiratory Pressure (PEEP) of 5 cm H₂O, adjusted to maintain EtCO₂ at 35-45 mmHg.

The intraoperative period was uneventful. Neuromuscular blockade was reversed with 60 mg i.v. sugammadex, and the patient was extubated when fully awake. Postoperative pain was managed with 500 mg i.v. paracetamol. She was monitored in the post-anaesthesia care unit and discharged the following day.

DISCUSSION

Achondroplasia is a rare hereditary autosomal dominant condition and the most common form of primary skeletal dysplasia in humans, accounting for over 90% of cases of dwarfism characterised by disproportionate small stature [1]. The term "achondroplasia" was first introduced in 1878 to distinguish it from rickets, which also involves abnormal bone growth [1,2]. Females are more commonly affected than males, with an incidence of approximately 1 in 20,000 to 30,000 live births [3].

Achondroplasia, classified as a growth plate dysplasia, is caused by impaired cartilage formation. The mutation responsible for this condition is located in the transmembrane region of Fibroblast Growth Factor Receptor 3 (FGFR3) [4]. Also, known as chondrodysplasia foetalis, achondroplasia is the primary cause of short-limbed dwarfism, characterised by retardation of endochondral bone formation at the epiphyseal growth plate and base of the skull. Typical features include macrocephaly with frontal bossing, midface hypoplasia, rhizomelic shortening of the limbs, short fingers with a characteristic trident hand (brachydactyly), and bowed legs (genu varum) [5,6]. Other associated features include kyphoscoliosis, spinal canal stenosis, maxillary hypoplasia, macroglossia, tracheal narrowing, rib hypoplasia, atlantoaxial joint instability and genu varum [7].

This case report highlights the challenges in anaesthetic management of an achondroplastic child undergoing split-thickness skin grafting. Anaesthetic management in achondroplasia requires a thorough understanding of the patient's unique anatomical and physiological characteristics, which increase the perioperative risk of cardiovascular and respiratory complications, including ventilation-perfusion mismatch, potential desaturation and difficult airway management. A positive history of snoring may indicate underlying Obstructive Sleep Apnoea (OSA), increasing the risk of perioperative hypoxemia and postoperative airway obstruction, necessitating careful airway planning and vigilant monitoring [8].

The most common anaesthetic concerns in achondroplasia include limited neck mobility, atlantoaxial joint instability and OSA. Under general anaesthesia, significant airway challenges are often encountered during both mask ventilation and tracheal intubation. A thorough preoperative assessment, potentially including advanced techniques such as fiberoptic or awake intubation, helps minimise the risks associated with airway management [9].

The management of 30% thermal burns was challenging due to the combined physiological impact of major burns and the anatomical difficulties inherent to achondroplasia. There was no significant blood loss. Fluid resuscitation formed the cornerstone of early burn

management. The modified Parkland formula of 4 mL/kg/% Total Body Surface Area (TBSA) using Ringer's lactate was applied, with half of the calculated volume (1,800 mL) delivered in the first 8 hours post-burn and the remainder over the next 16 hours. Maintenance fluids with glucose supplementation were also administered to prevent hypoglycaemia, given the limited glycogen reserves in children. Urine output was closely monitored and maintained at 1 mL/kg/h to guide resuscitation [10].

Kerosene burns in this child resulted in deep dermal and full-thickness injuries with extensive tissue necrosis. The wounds were initially cleansed, covered with topical antimicrobials such as silver sulfadiazine and dressed with sterile materials. Early excision and split-thickness skin grafting were planned to reduce the risk of sepsis and promote wound healing.

The patient was taken to the operating room in the supine position for wound wash and split-thickness skin grafting under general anaesthesia. Rocuronium was used as a muscle relaxant to facilitate endotracheal intubation, while succinylcholine was avoided due to the history of burns. In light of the anticipated difficult airway with a Cormack-Lehane grade of 2b, a Sandor (SANVL2) video laryngoscope was selected as the preferred method for intubation. Endotracheal intubation was performed using a 6.5-mm endotracheal tube with the video laryngoscope, which helped minimise neck movement, thereby preventing cervical spine injury. The video laryngoscope provided enhanced airway visualisation, allowing safer and more controlled intubation even in the presence of anatomical challenges. Correct tube placement was confirmed by bilateral air entry and capnography.

The patient's lean body weight was used to calculate appropriate anaesthetic dosages, providing a more accurate representation of actual drug requirements compared to total body weight. While there are no absolute contraindications to anaesthetic medications, care was taken to avoid agents that could worsen apnoea, contribute to respiratory depression, or exacerbate hyperkalemia. The anaesthetic plan was tailored to minimise the risk of airway obstruction or prolonged apnoea [11].

The choice of general anaesthesia with video laryngoscope-guided intubation was based on balancing the risks posed by achondroplasia and acute thermal burns. Anticipated risks included a difficult airway due to craniofacial abnormalities, macroglossia, and a short neck, combined with possible atlantoaxial instability. Regional anaesthesia, though useful in selected cases, carried significant risks in this patient due to spinal deformities, unpredictable drug spread and technical challenges related to stenosis and kyphoscoliosis. Extensive burns across the trunk also limited the feasibility of positioning for a neuraxial block.

The benefits of general anaesthesia included secure airway control, optimal surgical conditions and better management of intraoperative fluid shifts. The use of a video laryngoscope minimised cervical spine movement while improving glottic visualisation, reducing the risk of airway trauma and neurological compromise. Avoiding succinylcholine mitigated the risk of hyperkalemia in the post-burn state, while rocuronium with sugammadex ensured reliable muscle relaxation and rapid reversal. Ultrasound-guided venous access enhanced safety in the context of burn-related vascular changes and obesity.

In present case, authors employed general anaesthesia with video laryngoscope-guided intubation due to anticipated difficult intubation. Similarly, Teymourian H et al., reported airway management in a 28-year-old achondroplastic patient undergoing kyphosis correction. Video laryngoscopy allowed successful intubation with a size 6 cuffed endotracheal tube without neck extension, minimising cervical spine movement and avoiding potential injury. The authors emphasised that many achondroplastic patients require smaller-than-expected tube sizes and recommended preoperative echocardiography to screen for pulmonary hypertension, as well as preparedness for difficult neuraxial anaesthesia due to spinal abnormalities [12].

Fibreoptic intubation is considered the gold standard for managing difficult airways in thermal burns, as reported by Kim JH et al., however, this technique may not always be feasible due to inadequate patient cooperation, anxiety, or anatomical challenges, including smaller or distorted airways [13]. In such cases, an alternative method, such as in-line stabilisation combined with video laryngoscopy, can be effective and safer. This approach allows enhanced airway visualisation while maintaining cervical spine stability, crucial in patients with potential atlantoaxial instability. By reducing the need for manual neck manipulation, it minimises the risk of cervical spine injury and facilitates smoother, more controlled intubation [13].

Nedomová B et al., reported the use of a video laryngoscope combined with fiberoptic guidance after failed fibreoptic intubation during neurosurgical decompression in a patient with achondroplasia. Together with ultrasound-guided vascular access and intraoperative neuromonitoring, this approach contributed to complete neurological recovery within three months [14].

Regional anaesthesia is challenging due to anatomical anomalies associated with achondroplasia, including kyphoscoliosis, osteophyte formation, reduced interpedicular distance (particularly in the lower lumbar spine), pedicle shortening and vertebral canal stenosis. Spinal stenosis may impede cerebrospinal fluid flow, making dural puncture identification difficult. Determining the appropriate dose and volume of local anaesthetic for spinal or epidural anaesthesia is challenging, as anatomical abnormalities can lead to unpredictable spread of the anaesthetic, complicating the achievement of the desired block level.

There are no specific guidelines for local anaesthetic dosing in patients with achondroplasia. Ravenscroft A and Rout C, described spinal anaesthesia in an achondroplastic parturient undergoing caesarean section, highlighting the technical challenges due to craniofacial abnormalities, airway difficulty, spinal deformity and risk of cranio-cervical compression. General anaesthesia carries considerable risks related to airway instrumentation and potential neurological compromise. Their report emphasised that neuraxial anaesthesia can be safely performed in achondroplastic patients with careful titration, meticulous preparation, and readiness for failed block and difficult airway management [15].

Similarly, DeRenzo JS et al., reported an emergency caesarean section in an achondroplastic patient, using hyperbaric bupivacaine 10 mg with morphine 0.2 mg at the L3-L4 level for spinal anaesthesia. They emphasised that the narrowed spinal canal and reduced cerebrospinal fluid volume in achondroplastic patients make them susceptible to high or total spinal block if standard doses are used. Dose reduction, careful patient positioning, meticulous technique and vigilant monitoring ensured safe and effective anaesthesia [16]. Mitra S et al., described another emergency caesarean in an achondroplastic parturient where general anaesthesia posed high-risk. They administered 1 mL of 0.5% hyperbaric bupivacaine with 10 µg fentanyl intrathecally at the L3-L4 level, achieving a T4 sensory block. The patient remained stable, with only mild hypotension

managed with fluids and vasopressors. The authors concluded that low-dose spinal anaesthesia with opioid adjuvant is safe and effective in such cases [17].

CONCLUSION(S)

Anaesthetic management in patients with achondroplasia and thermal burns requires careful recognition of challenges related to difficult airway management and venous access. Characteristic anatomical features make airway management particularly difficult. In such cases, a video laryngoscope is highly useful, providing better airway visualisation while minimising neck movement, thereby reducing the risk of injury. Venous cannulation can also be more difficult due to thermal injuries, excess subcutaneous tissue, and smaller veins, necessitating careful technique and, where appropriate, ultrasound guidance to ensure successful access.

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